Air Force Dual Use Science & Technology
1998/1999 Competition
Technology Focus Areas

The Air Force Dual Use Science & Technology (AF DUS&T) program manager and central point of contact is Mr. Richard Flake 937 656-9015. Additional information about the AF DUS&T program including the 1998/1999 Competition can be found on the Internet at: http://tto.wpafb.af.mil/TTO/dualuse/index.htm. Each topic area listed below identifies the technical point of contact through which any technical questions and the white papers should be submitted. All final proposals should be sent to the corresponding Contracting Officer (CO) listed at the end of each topic area.

Affordable Sensor Technology -- In the 21st century, the performance of many sensing devices, as currently designed, will begin nearing the fundamental limits of physics. Continued improvements in performance will only be possible by miniaturization, automation, sensor integration, sensor fusion, digitization, and seamless information distribution. Sensors will need to provide a near real-time picture of the battlefield and they will need to operate during the day, at night and in all weather conditions. This area seeks to partner with commercial industry to tap into advances in commercial sensors and develop the sensor hardware, software, and system architecture needed to meet both the future needs of the military as well as commercial market. In addition, commonality between commercial and military sensors will help reduce the cost of sensors for both markets. Sensor technologies of interest include acoustic sensor arrays, seismic sensors, biological/chemical/nuclear agent detectors, laser radars, and location/navigation sensors.

DE-1

TITLE: GROUND-BASED IMAGING AND INSPECTION OF ORBITING SATELLITES

OBJECTIVE: Explore the use of Air Force ground-based optical imaging technologies and assets for the detection of anomalies occurring on commercial satellites. In particular, determine and demonstrate the utility of using these technologies for commercial purposes and develop a business plan that identifies the role of the Government, DoD contractors, satellite owners and insurers. This project is seen as an experimental step toward a more substantial dual-use arrangement. Applying Air Force technologies to interesting and unusual situations involving commercial spacecraft malfunctions will drive new software and hardware

verifying telemetry diagnostic data, and providing information for design improvements and insurance claims.

DESCRIPTION: Optical imaging of low-earth-orbit spacecraft requires the use of specialized assets such as fast-tracking telescopes, low-light camera systems, and image recovery and processing expertise. Currently, these assets exist exclusively in the DoD - primarily in the Air Force. Commercial low-earth-orbit satellite constellations for communications, such as the 64-satellite Iridium program, provide a unique situation for the application and further development of optical imaging approaches. Under this project new analysis algorithms and software may need to be developed that incorporate known physical features of particular satellites or historical data on typical satellite failures. Demonstrations of the use of optical imagery for solving specific commercial satellite problems will be performed. The business plan that is developed must address telescope and hardware time sharing issues, security questions and cost reimbursement approaches. Partnerships formed between satellite manufacturers, owners, insurers and image processing specialists are particularly encouraged

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $200K

Estimated Program Duration: 24 to 36 months

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compacted and ruggedized for field applications. In these situations, unit cost, weight, and size tend to be primary drivers. For many military applications, good beam quality and high efficiency are also highly desirable. Both pulsed and Continuous Wave (CW) operation is important, dependent on the intended application. Commercial applications of this technology include materials processing, pump sources for frequency conversion, and remote sensing.

DESCRIPTION: The development of low-cost, solid-state laser sources will enable many laser-based applications that are cost-sensitive and will benefit both the military and commercial sectors. Innovative laser packaging solutions, such as monolithic designs or highly integrated assemblies, should be explored. Designs that can be mass-produced are highly desirable. Goals for this project are to: (1) develop a laser architecture scalable to tens of watts, (2) reduce laser cost by a factor of ten relative to current costs when mass produced, (3) maintain or improve laser performance (beam quality, efficiency, stability, etc) relative to current systems, and (4) achieve reliability (as measured by MTBF) of 1000s of hours. Proposals should address the following areas: (1) Potential for mass production, (2) potential cost reduction relative to established fabrication methods, (3) approach to compacting and ruggedization, (4) methods for achieving high efficiency and beam quality, and (5) critical technical risk areas of the proposed solution.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1200K

Estimated Program Duration: 36 months

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OBJECTIVE: New designs are sought for very lightweight, ultra-wideband (UWB) antennas for applications to UWB pulse or multi-band continuous wave transmission and reception. Both focused beam and omni-directional designs are desired. Balanced and unbalanced designs will be considered. High power transmission capability, as well as very low signal level reception, is desirable. The benefit to the military will be realized as an increase in performance of the communications systems on ground stations, ships, satellites, and aircraft as well as the ability to transmit and receive wideband, fast transient pulses for foliage penetration and ground penetration applications. Potential commercial applications include antennas for multi-band communications on ground stations, ships, aircraft, and satellites.

DESCRIPTION: The development of advanced antenna technologies to reduce the weight and increase the information carrying capability of communications and radar antennas will benefit both the military and the commercial sectors by increasing capability and saving weight and space aboard new systems being designed for the 21st century. Particular emphasis should be placed on wide bandwidth, reduced weight, structural integrity, reliability, pattern, constant impedance, and low dispersion. Successful proposals in this topic area will develop UWB antennas that will substantially reduce the weight and space requirements and increase the information carrying capability of the systems.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $900K

Estimated Program Duration: 36 months

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TITLE: REAL-TIME MODEL-BASED OBJECT ORIENTATION DETERMINATION SYSTEM

OBJECTIVE: Develop a general-purpose processing component or module for visually tracking the position and orientation of an object. The component or module could be embedded in a variety of systems to achieve the following objectives.

1) Reduce the total system cost and increase the capabilities of manufacturing robots or repair robots, by enabling them to autonomously identify the orientations of parts and grasp them for assembly or repair.
2) Extend the on-orbit lifetime of expensive commercial and military space assets by enabling an orbital servicing satellite to continuously monitor the orientation of a non-operating satellite in order to dock with and repair the satellite.
3) Provide real-time knowledge of foreign satellite activity to military users and real-time health, status, and anomaly resolution of domestic satellites by commercial and military owner-operators by analyzing imagery collected with ground-based optical telescopes.

DESCRIPTION: Develop computer software or a combination of software and hardware which, given a 3D model of an arbitrary object, continuously and automatically computes the position and orientation of the object in an image sequence or video stream. The system must allow for models containing articulating components, such as a hinge which may be partially opened to an unknown degree, or a solar panel which may be pointing in an arbitrary direction, and must be robust with respect to various and unknown lighting conditions. Many existing techniques rely on simulating numerous images of the 3D model in advance, and are therefore cannot easily accommodate lighting or articulation changes. Increasing computation capabilities have now made other approaches feasible, such as rendering the object in real-time or matching object features with image features in real-time. The objective is to obtain sub-1Hz orientation updates using readily available processing hardware.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $250K

Estimated Program Duration: 24 months

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MN-1

TITLE: AGENT DEFEAT/FACILITY DENIAL

OBJECTIVE: The specific objective of this program is to develop air-deliverable warhead technologies that deny an enemy the use of C/B weapons with minimal collateral damage (i.e., limit the mass of viable chemical or biological agent vented to the environment as a result of an attack on a chemical or biological agent product or storage facility). Denial of a facility may be more robust than defeat of the target contents (damaging target contents). It also provides an opportunity to meet the stringent collateral damage criteria. Under this effort, technologies will be identified and limited experimentation conducted to support development and demonstration in future munitions programs. Technologies identified during this effort will support agent defeat efforts, and hard target and small smart bomb visions. Technologies developed under this effort will support commercial developments in non-lethal, facility denial products and law enforcement.

DESCRIPTION: Of the three types of Weapons of Mass Destruction (WMD), Chemical and Biological (C/B) Weapons are the most widespread, but are also difficult to counter their deployment. They are the weapon of choice in many rogue nations because of cost, low technological expertise required, availability, and ease of delivery. They are the most difficult to counter because of the likelihood of high collateral damage if attacked with existing weapon systems that deliver conventional high explosives. Current conventional weapons cannot successfully accomplish the mission of destroying hard or soft C/B production and storage facilities with minimal collateral damage assured. Inventory weapons tend to expel an unacceptably large amount of agent into the

of C/B weapons with minimal collateral damage (i.e., limit the mass of viable chemical or biological agent vented to the environment as a result of an attack on a chemical or biological agent product or storage facility). Present work has focused on neutralization technologies that have some limitations on application and effectiveness. Facility denial technologies would not have the limitation associated with target knowledge of neutralization technologies. It is expected that this effort would identify promising, air-deliverable munitions, denial concepts and technology for future development and refinement. These technologies and concept would provide the basis for future innovative munitions.

Facility Denial technologies generally focus on non-lethal technologies aimed at eliminating access to a facility (room, building, area) in such a manner as to not damage the facility contents or occupants. Many of these technologies are currently under development for small-scale application in the law enforcement and crowd control. AFRL/MN efforts are focused to exploit existing technologies with larger scale application potential and to develop new non-lethal area denial technologies. Many law enforcement agencies, major corporations, and security companies desire the same non-lethal technologies.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $250K

Estimated Program Duration: 12 –24 months

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technologies. These integrated devices would be useful in a variety of military applications where multiple sensing and decision-making is desired. The integration of multiple functions on a single chip will simplify the processing of the input data from each device. This will result in an enhanced decision making process with lowered overall processing overhead.

The commercial market would benefit from this device in several ways. The automobile industry currently uses a RF radar device for collision avoidance, an accelerometer for air bag systems, and a rotational/velocity measuring device for antilock braking systems. These devices are all on different chips, which cost more than a multi-function single chip. In addition, integrated chip technology can economically be applied to many other applications. The IR, UV and radar features of a chip can be integrated to provide better imaging of objects to assist in collision avoidance. Other commercial applications use the UV portion of the device for food freshness information and the IR component to determine if food is being cooked and stored at the correct temperature. Environmental detectors can be used to monitor and adjust processes to limit excess emissions from automobiles and factories with a single, cost effective chip.

DESCRIPTION: In recent years, the development of Micro Electromechanical Systems (MEMS) has resulted in the ability to manufacture microscale electromechanical systems that can be incorporated on micro controllers and processors. Previously developed distinct MEMS devices include RF emitters and detectors, accelerometers, global positioning system (GPS) receivers, and IR detection devices. Other MEMS technologies currently under development that will prove beneficial include nonvolatile memory with fast read/write capabilities, a gyroscope, a velocity measuring device, an energy storage device, an environmental sensor, an oscillator (CMOS precision or crystal clock), and a UV detection device/sensor. MEMS sensor devices could be combined with current micro fluid technology to allow for precise endothermic chemical reactions resulting in the cooling of the IR sensor for better performance. However, the fusion of a number of individual devices on a single chip has yet to be accomplished.

inch) and would facilitate miniaturized fuzing applications with high g and high velocity capability.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: 280K

Estimated Program Duration: 30 Months

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SN-1

TITLE: SILICON BASED LWIR THERMAL SENSORS

OBJECTIVE: Develop an all silicon, low power, longwave infrared (LWIR) detector that could be designed to operate at 400K (Kelvin), 300K, or 200K. It would reduce the unit sensor cost by leveraging the silicon technology infrastructure, reducing the system power requirements, and serving multiple Air Force missions and commercial products. DoD applications include imaging for a missile seeker, multiple aircraft sensor 4π-steradian threat warning, and passively cooled thermal imaging from space. Commercial applications include security systems, collision avoidance imaging for automobiles, aircraft landing systems for night and bad weather, and space based imaging for soil characterization and crop analysis.

DESCRIPTION: Uncooled LWIR sensors are available from multiple

have recently developed the theory of operation for a new class of Bolometer, based on thermionic emission. In addition, a thermionic thermal detecting (TTD) element, made from silicon, has been electrically demonstrated that is suitable for 300K operation. Detectors designed for operation at 200K and 400K still need to be demonstrated to meet the above commercial and military requirements. The TTD can then be substituted into a conventional Bolometer multiplexer as a low cost mechanism to demonstrate the sensor. The goal is to develop an uncooled LWIR detector, using silicon technology, that operates at 400K, 300K, and 200K, that is much lower in cost, power, and weight, while being much more reliable and three times more sensitive than current uncooled detectors.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $500K

Estimated Program Duration: 4Yrs

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SN-2

TITLE: 2D OPTICAL LOCK-IN IMAGE DETECTION

OBJECTIVE: Develop synchronous image detectors that will provide real-time analysis of low to sub-background optical signals in military and commercial applications. Current optical detectors can be combined with on-chip homodyne or heterodyne electronics to provide a high-speed miniature opto-electronic parallel processing smart sensor array. This new technology in miniaturized parallel optical signal detectors provides substantial processing speed improvements for guided and free space optical communication receivers; for measuring beam aberrations from atmospheric turbulence to correct optical wavefronts; and for performing imaging measurements of frequency shifts to determine surface metrology, structural analysis and motion detection. Such detectors can be

in background noise. The optical input includes a temporally modulated signal component that may be separated from the noise component by phase-sensitive detection and time-integration. This provides a two dimensional implementation of conventional electronic one-dimensional lock-in or phase sensitive signal detection. With the current technology in optical modulation and detection, the speed of this opto-electronic lock-in device is primarily limited by the electronics used for averaging, control and 2D read-out. This device would have a spatial resolution of 30 microns in arrays of at least 32x32 pixels. It would operate over the wavelength range of 1 to 1.5 microns and provide ability for external control of the coherent reference signal and the averaging time.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $600K

Estimated Program Duration: 36 months

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SN-3

TITLE: MULTI-SENSOR FUSION RF CLUTTER MODELING

OBJECTIVE: The objective of this topic area is to develop a tool for investigating the combining of information from multiple sensors (i.e. fusion) to accurately analyze and classify electromagnetic radiation while

recognition, intelligence and surveillance, and space based reconnaissance all utilize algorithms that can benefit from insertion of sensor fusion information. In designing commercial wireless networks for fixed and mobile systems, planners attempt to maximize system reliability while minimizing infrastructure and design costs. At a technical level, this implies a balance between three competing goals: 1) maximize coverage by each base station, 2) minimize interference between base stations, and 3) limit radio spectrum usage. Interference between these base-station cells is generally managed through a combination of spatial and spectral diversity. The current state of the art in commercial satellite imagery could also benefit from this type of analysis tool.

DESCRIPTION: The tool should integrate geographic information systems (GIS), visualization, and 3-D propagation analysis into a single package. A physical model that accounts for the diverse propagation mechanisms encountered in complex environments: line-of-site, ground-bounce, multi-bounce off buildings and terrain, diffraction over hills, diffraction around buildings, etc is desired. To maximize utility, the simulator should combine scene/network visualization with coverage and interference overlays on the terrain. Display of the volumetric antenna patterns in the scene, combined with visual indicators of the various propagation paths from transmitter to receiver, will serve a valuable diagnostic role for optimizing antenna installation. Such a package should allow for the investigation of multiple scenarios for signal and imagery analysis and provide a realistic sensor environment to enable analysis of next generation ATR and sensor fusion algorithms.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $480K

Estimated Program Duration: 24 to 30 months

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OBJECTIVE: Provide bird hazard detection and warning in the vicinity of airfield, and in the takeoff, climb, and landing approach zones. Since virtually all bird strikes occur at altitudes below 5000 ft, the detection system should provide bird hazard detection and warning out to 12 to 15 nautical miles from the airfield. Increasing air traffic and the continued changes in the habits of migratory and indigenous birds have resulted in an increase in the number of bird aircraft strikes in recent years. This is true at both military and civilian airfields worldwide. For example, the recent crash of an AWACS aircraft at Elmendorf AFB, Alaska in Nov 1995 resulted in the loss of all crewmembers and operators onboard. The current state-of-the-art in airport surveillance and weather radar results in limited applicability of the conventional detector/tracker for bird warning, due to the large number of targets (birds) in the surveillance volume. The analysis of measurement data from Dover AFB, Delaware indicates that patterns of activity arise which provides useful prior knowledge to be exploited in a radar based automatic bird aircraft strike hazard warning system.

DESCRIPTION: The development and demonstration of means for detection and warning of bird hazards in the vicinity of airfields, and in particular, the takeoff, climb and landing approach zones. The system should be a relatively low cost addition to the current airfield surveillance equipment, should operate in conjunction with the airfield surveillance system, but on a non-interference basis. The system should be capable of detecting and locating bird hazards out to at least 12 nm from the airfield, and provide processing to enhance the detection of birds while rejecting clutter to the maximum possible extent. The technologies to be emphasized: (1) enhanced sensitivity for the detection of the low radar cross section of birds, (2) digital time-lapse processing to enable the rapid viewing of the ingress and egress of birds from the airfield vicinity, (3) signal processing techniques for separating birds from clutter, and (4) image processing techniques to enhance bird detections while rejecting clutter. Successful proposals in this topic area will develop and demonstrate equipment for bird hazard detection and warning will elicit the comments from both civilian and military airfield controllers and bird control personnel in the implementation of the systems, associated displays and warning systems. Major milestones including contact award

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SN-5

TITLE: ULTRA-EFFICIENT MICROWAVE AMPLIFIER FOR SPACE

OBJECTIVE: Development of ultra-efficient microwave amplifiers for lower system level power consumption in space applications. Commercial space applications for this technology include power amplifiers for phased array systems for satellite personal communications. The IRIDIUM constellation with as many as 20,000 MMIC T/R modules per constellation is an example of this. Military space applications include future space-based radar systems, which would support the next-generation functionality of AWACs and JSTARs.

DESCRIPTION: Ultra-efficient, solid-state microwave amplifiers are required for space applications. Improved amplifier power-added efficiencies result in lower system-level power consumption. Power consumption translates directly into power system weight, thermal control system weight, and hence satellite and launch weights, and satellite and launch cost. The ultra-efficient, UHF through X-band amplifiers would require >85% power-added efficiency at L-band and >70% power-added efficiency at X-band, as well as 1/4 watt to 10 watt output power depending on the antenna configuration. The microwave amplifier should be based on a device process capable of providing ultra-high efficiency, as

evaluation/improvements for long-term microwave power performance in support of a viable commercial process should also be addressed. Teaming arrangements are recommended to ensure customer involvement as the ultra-efficient device/amplifier technology proceeds from development through commercial production.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $2.26 M

Estimated Program Duration: 36 months

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SN-6

TITLE: LOW POWER ANALOG-TO-DIGITAL CONVERTERS (ADCS) FOR SPACE APPLICATIONS

OBJECTIVES: Develop and demonstrate low-power, high performance, radiation-hard Analog-to-Digital Converters, and support electronics for space-based sensor platforms. It is anticipated that demonstrated components will be used in advanced digital receiver concepts such as the ones envisioned for Space-based Radar (SBR), Signal Intelligent (SIGINT) systems, and commercial satellite communication (SATCOM) systems. The technical approach will emphasize the use of advanced device concepts and circuit architectures that will enable the demonstration of low power, radiation tolerant Analog-to-Digital (A/D)

DESCRIPTION: The hardware and software associated with sensing functions in military and commercial systems are generally major and sometimes predominant contributors to their performance, reliability, supportability, and cost. In the next several decades, the Air Force will have an increased need for fine resolution imaging of targets and scenes of interest. Acquiring such imagery in demand for any place on the globe will be challenging but essential, given the increasing mobility of enemy threats and terrorists and the rapid pace with which events can unfold. The need for these capabilities suggests that a very large number of space-based platforms providing global coverage will need to be designed and deployed during the next decade. It is likely that many RF space-based assets will depend heavily on lower cost, digital processing eliminating the use of bulky, and power hungry analog processors. Furthermore, demonstration of low power, environment-immune Analog-to-Digital Converters will enable the demonstration of space assets with full digital signal path implementation for electronic and information warfare in space. In addition, there are many commercial applications that can benefit from the use of low cost, low power Analog-to-Digital Converters including, communications (e.g. digital wireless systems, satellite communications and links, aircraft communication and navigation systems, etc.), instrumentation, and medical imaging systems.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $2.1M

Estimated Program Duration: 36 months

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OBJECTIVE: The program will use the latest gallium nitride technology to produce electronic devices and circuits for harsh environments. A militarily harsh environment can consist of extreme temperatures and exposure to radiation. The robust circuits will operate at peak temperatures of 500°C. The proposed program should demonstrate devices and circuits suitable for either analog-to-digital converters, microwave amplifiers, or microwave receivers which are required for military sensors with limited environmental control. The thermal considerations are critical, since state-of-the-art devices are thermally limited rather than electronically limited.

Similar problems are faced in the huge area of commercial applications. For example, it involves automobiles, commercial satellites, commercial aerospace, manufacturing equipment, and oil exploration. At times these environments can be as harsh and demanding as the battlefield. In addition to the specific three potential applications for the AF DUS&T, the wider commercial and military applications also involve operational amplifiers, transducers, micro-controllers, and high-speed processors. For example, European and Asian companies are also developing gallium nitride and other wide bandgap robust technology for automotive sensor applications and other applications in radiation environments, boilers, and motors. Therefore, the efforts associated with developing the AF DUS&T specific devices and circuits can also be readily applied to the larger, viable worldwide commercial market.

DESCRIPTION: The proposed program will leverage the substantial investments in gallium nitride light-emitting diodes and lasers. The commercial market is already making large investments in gallium nitride growth and characterization since the material exhibits promising optical qualities unlike other wide bandgap materials. The potential market for gallium nitride optical devices is estimated to be as high as $2 Billion. Therefore, unlike other wide bandgap materials, the Air Force can leverage the developments obtained from the commercial optical market to realize robust, high-speed, high-power electronic devices for militarily critical technology. For example, while the basic materials and substrates are refined with commercial dollars for optical applications, the additional processing developments required for robust, high-power transistors can

Estimated Program Duration: 24 to 36 months

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SN-8

TITLE: ADVANCED PACKAGING TECHNIQUES FOR SPACE APPLICATIONS

OBJECTIVE: The objective of this program is to develop low profile mixed signal packaging and interconnect technologies for the fabrication, protection, assembly, and integration of high performance microwave and millimeter wave sub-assemblies. These sub-assemblies are required for advanced high performance sensor sub-systems and signal processing applications. Significant military capabilities in aerospace applications such as UAV radar and space-based radar will be enabled by increased integration through advanced packaging. The technologies developed as part of this effort can also be used in several commercial applications such as automotive systems, computers, wireless communications, satellites and navigation (GPS) aids. Increased integration will provide more functionality per unit volume, compatibility with lower voltage components, higher reliability and more affordable sub-system costs.

DESCRIPTION: This program anticipates one or more awards and will build upon advancements in integrated passive components, surface protective coatings, thermal management techniques, and more innovative

likely include a concept tradeoff study, concept feasibility verification, hardware demonstration and limited environmental tests, in the appropriate environment by the end of the program.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1.848M

Estimated Program Duration: 24 to 36 months

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SN-9

TITLE: STRATEGIC SUBSURFACE DETECTION PROGRAM

OBJECTIVE: Develop a high frequency (HF) radar system that can be used in the detection and identification of subsurface structures. The proliferation of underground structures for military command and control posts as well as the manufacture and storage of weapons of mass destruction has increased the need for remote sensing technologies which provide the detection and identification of such structures. Remote sensing via HF radar could provide the depth of penetration and resolution

as well as the location of underground geological formations. The Mine Safety and Health Administration is interested in 3-D mapping of existing working mines. The technology could be used to find voids or air pockets after a mine cave-in as part of a search and rescue mission. The technology would also be used to plan mining operations to avoid excavation into water pockets and thereby avert flooding. Three key technologies are emphasized: (1) radar antenna technology to combine small, low frequency, and broad band capability, (2) signal processing development in near field SAR (Synthetic Aperture Radar), and (3) transmitter and receiver design. Successful proposals in this topic area will develop ground penetrating radar technologies to increase detection depth and resolution in spite of the high attenuation caused by the subsurface geology and the air-ground interface. These technology areas are necessary for both the military and the civilian application.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $600K

Estimated Program Duration: 30 months

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SN-10

TITLE: A REAL TIME OBJECT ORIENTED IMAGE AND VIDEO COMPRESSION SYSTEM

OBJECTIVE: We wish to develop this real time object based

generation commercial television and video system. This system approach has applications that include cancer detection, weather radar, and x-ray analysis. Other civilian applications include Internet video, interactive DVD, and web television.

DESCRIPTION: Software for this project should be developed in a World Wide Web interactive programming environment. This compression system should have real time capability on standard PC-based platforms and be affordable by an average consumer. Once compressed, the video should be played or database matched in the compressed domain on an object by object basis. The World Wide Web interface should allow the user to train the compression system as well as monitor the compressed video and search results. A World Wide Web streaming video interface as well as a web integrated object database search engine should be designed.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $2M

Estimated Program Duration: 24 to 30 months

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SN-11

TITLE: MICRO ELECTRO MECHANICAL SYSTEMS (MEMS) PHASED ARRAY ANTENNA FOR SPACE BASED SENSOR APPLICATIONS

going toward the development of various device technologies: accelerometers; gyroscopes; chemical and pressure sensors, and phase shifters. The purpose of this effort is to investigate the application of MEMS technology for wide bandwidth, multi-function Space Based Sensor Applications. Paramount to this investigation is a demonstration of a MEMS-based Sensor in a laboratory environment. The design, fabrication, and test of a functional subarray should serve as a proof of concept.

Several commercial opportunities exist for use of MEMS technologies for automotive applications including: adaptive speed control; collision avoidance/warning; and automated brake application.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1M

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SN-12

TITLE: High-Gain Near-Infrared Avalanche Photodiode

OBJECTIVE: The objective of this program is to develop a new near-infrared
(1.0 to 1.6 micron) avalanche photodiode (APD) that has higher gain, higher speed and lower noise than presently available devices. Higher sensitivity photodetectors will satisfy a critical military need to detect weak optical signals for applications including ladar, target identification and free-space optical communications. Commercial needs for higher

and demonstrated operation of new long wavelength high performance APDs. One example is the development of a new APD structure, which uses a silicon multiplication region and an indium-gallium-arsenide absorption region. This device has shown high sensitivity, very high speed, low noise and high temperature and voltage stability. A new high sensitivity, high speed APD receiver will substantially improve the performance of military ladar and target identification systems and will increase the data capacity of free-space optical communications systems. Commercial fiber-optic applications including SONETs and long haul terrestrial and transoceanic links, where increased sensitivity will reduce the number of repeaters needed, will realize enormous reliability and cost advantages.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $600K

Estimated Program Duration: 36 months

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VA-2

TITLE: STRUCTURALLY EMBEDDED CABLING, CONDUCTORS, AND SENSORS

OBJECTIVE: Develop and demonstrate embedment of electrical cabling, conductors, and sensors in composite air vehicle structure. This technology addresses the Air Force's goal to reduce the acquisition cost, weight, and supportability cost of weapon systems. Embedded cabling,

embedment will provide a high degree of damage protection by isolating cables from high strain levels and susceptibility to damage. Commercially, this technology will be highly applicable to aviation and space systems and provide cost, weight, and supportability payoffs equivalent to military air vehicles. Perhaps most importantly, the improved damage protection and durability enabled by embedment will increase the safety of commercial vehicles. Damage to exposed cabling is hazardous and an increasingly severe problem as systems age. The weight savings provided by this technology are also particularly valuable to commercial systems. Commercial airliners will save hundreds of pounds per aircraft as well as significant cost savings by incorporating cables in lightweight composite floor panels. The weight savings would allow for increased cargo weight or improved fuel efficiency improving airline profitability. Space systems will benefit tremendously from the weight savings, lowering the cost to orbit.

DESCRIPTION: This focus area seeks to demonstrate the concept of embedding electrical cabling, conductors, and sensors in composite air vehicle structure. This concept will eliminate the need for parasitic installation of these items and provide synergistic benefits by allowing the structure to provide damage protection and insulation. This program shall develop design concepts for military air vehicles, demonstrate manufacturing concepts, and validate performance through relevant testing. Cost savings, weight savings, and supportability enhancements shall be documented. Embedment approaches and component interconnect concepts should be demonstrated. Structural, electrical, and environmental integrity of the concept should be demonstrated through realistic testing.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $400K

Estimated Program Duration: 24 to 36 months

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VA-3

TITLE: EMBEDDED SENSORS FOR COMPOSITE HEALTH MONITORING

OBJECTIVE: The objective of this work is to determine the usefulness of the newest class of fiber optic strain sensors for composite structural health monitoring.

Automated, in-flight, real-time, aircraft structural health monitoring could be accomplished by applying an array of sensors to an aircraft. This type of system offers many advantages to military air operations. For example, an on-board processor could collect signals from each sensor during flight and notify the pilot when ground maintenance was necessary. This would significantly reduce downtime due to ground-based inspection and allow the aircraft to spend more time completing more missions. In addition to maintenance information, the sensor array could provide a wealth of necessary information to the pilot. Examples of this information are: warning systems that could advise the pilot when a high-G maneuver is overstressing the aircraft; and a system for evaluating the significance of ballistic impact damage on the vehicles structure. Although the idea behind the in-flight monitoring is not new, limitations of sensor technology have precluded the implementation of the system. The new sensors that will be evaluated in this program overcome many previous shortcomings.

In addition to aircraft maintenance benefits, this program would expand the data collection capability of the AFRL. Simply put, the program will provide the capability to fully characterize the three-dimensional (3D), internal state of strain of a structure where current capabilities are limited to two dimensional external strain. Fiber optic sensors would also be very useful during explosive strain rate testing because of their fast sampling rate and their resistance to electro-magnetic noise.

Although there are several DoD programs currently looking at smart structures, no program is geared to collecting 3D internal strain measurement for health monitoring. This program will transition manufacturing expertise, the necessary conditions for accurate strain monitoring using small, internal gages (i.e. maximum gage spacing,

obvious candidates for this technology, there are several other industries that will find it useful as well. The nuclear power industry is currently conducting research (in conjunction with the DOE) into remotely monitoring the health of metallic and composite structures. A remote monitoring system is necessary for this industry since many components may become embrittled due to their service in a nuclear reactor environment. Another commercial application being considered is the health monitoring of composite bridges. Several bridge designers are already undertaking internal health monitoring of these bridges. However, the sensors currently used by bridge makers and the nuclear industry are not as capable as the new class of sensors that will be used in this project. The added functionality of these sensors will allow them to collect more data than those currently available, thus saving weight and being more cost effective.

DESCRIPTION: The development of fiber optic sensors has developed at a rapid pace in the past decade. There are new fiber optic sensors that are small enough to monitor the internal strain of composite structures without affecting the global structural response. This new class of sensors is a significant improvement over previous gages that were either too large, only able to monitor the strain on the composite surface, unable to survive cure temperatures or unable to capture all three components of strain. However, before these devices can be used effectively to monitor structural health, several questions must be answered. These concerns include location and quantity of the sensors necessary to capture any significant damage development, relation of sensor output to structural health and discrimination of damage type (i.e. ballistic impact, tool-drop, corrosion, fatigue, etc.) based on sensor output. The purpose of this program is to determine the usefulness of this new class of sensor for monitoring structural health. To do this, composite plates will be fabricated with internal sensors. Tests will be run to determine the variation of internal quantities with mechanical loading. The envisioned test matrix will account for material dependence on loading rate, repeated loading and laminate orientation. Once the tests are completed, a methodology relating internal composite quantities to overall mechanical behavior must be developed. Program milestones include a preliminary design study on placement of the internal gages, overcoming any difficulties involved with embedding sensors during the manufacturing

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VS-3

TITLE: POWER MANAGEMENT, DISTRIBUTION, CONDITIONING, AND THERMAL MANAGEMENT TECHNOLOGIES FOR SPACE BASED RADAR

OBJECTIVE: To develop electrical power management, distribution, and conditioning system and component technologies for use on 50 – 100kWe class satellites. These high electrical powers will enable a number of missions in space including many space based radar concepts, space based laser concepts, jam resistant communications, communications jamming capability, and a reduction in the number of satellites required for present missions by allowing operations at higher orbits. The commercial uses for these high power capabilities of power management and distribution technologies include communications satellites, computer industry, and facilities that have high demands on power quality.

DESCRIPTION: Electrical power management, distribution, and conditioning system and component technologies are needed for high power military and commercial space based systems. These technology development efforts shall focus on weight, volume and cost reductions and improvements in efficiency, radiation hardness and power quality. Innovations in modular/distributed high voltage (up to 240 VDC) and high power density (up to 500 W/lb) power distribution architectures and high

busses are desired for the acquisition and rejection of high thermal loads. Such systems should offer mass savings. The program must also deal with the high power issues due to the space environment such as surface charge build up and corona/arcing. These considerations shall also be considered in the proposed efforts. Ground demonstrations of a complete space power subsystem (up to 100 KW) and/or critical component technologies such as those required for a space-based radar system are highly desirable. Technologies must show a mutual benefit for military space systems as well as commercial applications. Multiple awards managed by both AFRL/VSDVP and AFRL/PRP are expected under this program.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: 8M

Estimated Program Duration: 40 months

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VS-4

TITLE: SOLAR THERMAL TO ELECTRIC CONVERSION TECHNOLOGIES FOR SPACED BASED RADAR AND SPACED BASED LASER

OBJECTIVE: To Develop a power conversion system capable of delivering greater than 50kW (electric) suitable for use on a satellite platform. Reliability, cost, mass, performance (efficiency), modularity and volume are critical issues. Mission lengths are expected to exceed 10 years, performance levels are end-of-life values. The system should not

DESCRIPTION: High performance thermal to electric power conversion systems and component technologies are needed for a growing number of future military and commercial space systems. The technology development effort should focus on mass, volume and cost reductions and improvements in efficiency, radiation hardness and power quality to satisfy the power demands of systems such as pulsed active, aperture phased array radar. These efforts should target 30 W/kg for the system including the following component technologies: collector, receiver, absorber (if thermal energy storage is considered), converter and thermal radiator. Volume constraints for various launch vehicles should also be considered, as deployment costs are considerable. Ground demonstrations of a complete ~100 kW space based power subsystem and/or critical component technologies are highly desirable. Technologies must show a mutual benefit for both military (e.g., space-based radar and laser) systems as well as commercial applications.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: 5.2M

Estimated Program Duration: Example 36 months

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VS-5

TITLE: SPACE QUALIFIABLE, LONG LIFETIME, MINIATURIZED MECHANICAL FLUID PUMP

require the dissipation of large amounts of power, but also for military and commercial aircraft and ground systems including hypersonic vehicles, remote power stations, automotive electronics, and consumer electronics.

DESCRIPTION: The continuing trend of higher power density (Watts/kg) satellites and payloads has led to a situation where the ability of passive thermal management concepts are quickly being exceeded. One particular example of this trend is the advanced packaging of electronics in 3 dimensional stacks of multi-chip modules (MCMs). Future systems will require not only that heat is transported away from sources in an efficient manner, but also that any thermal management concept:

- prevent thermal gradients greater than 1° C or less,
- handle pulsed power operations, and
- allow for easy decoupling of various components in a system for rework and on the fly integration.

One of the best solutions to meet such needs is a mechanically pumped loop with quick disconnects. The loop must be able to operate in a space environment with a lifetime of 10 years or longer, and have a significant pumping head to allow for small flow areas and long transport distances.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1.5M

Estimated Program Duration: 30 to 36 months

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Inter Continental Ballistic Missiles (ICBM) and tactical missile systems. Since present techniques for Graphite/Epoxy motor case damage detection are insufficient for detecting all potentially serious case damages the reliability of these systems is compromised. This technology could save billions of dollars by helping to prevent launch failures. Most importantly, warfighter effectiveness will be increased due to higher space lift and missile system reliability. Launch of commercial payloads into space is a growing industry due to the great increases in the telecommunication satellites business. Solid rocket motors with composite cases are a key to the low cost launch capability needed in commercial ventures. Effective techniques to detect and quantify case damage will lower the operations and insurance costs of launch systems while increasing the reliability. These systems will provide competitive advantages in the commercial market by greatly increase the efficiency of detection and quantifying of damage through incorporation of new NDE technologies and decrease costs by automating much of the labor involved with the data analysis.

DESCRIPTION: This program will develop the technology for a Non-Destructive Evaluation NDE process that can detect, locate, and quantify fiber breakage in graphite/epoxy rocket motor cases. Ultimately this technique should also detect all subsurface anomalies including damaged fibers and ply waviness. This information will then be coupled with other flaw detection and modeling capabilities to fully characterize the nature of damage to the case. The technology that results from these efforts will then be used to produce a field portable device that can be brought in when damage is suspected and can be used to determine if a motor needs to be removed from the inventory and examined in more detail. This system will greatly increase the efficiency of detection and quantifying of damage by automating much of the labor involved with the data analysis. Finally, new and innovative handling technologies will be developed which will lessen the risk of impact and stress damage to Graphite/Epoxy motor cases.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $8250K

Estimated Program Duration: 24 to 48 months

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X-2

TITLE: CONTINUOUS HEALTH MONITORING OF COMPOSITE STRUCTURES

OBJECTIVE: To develop monitoring technology to ensure mission success of composite structures. Given the increasing reliance on composite structures and pressure vessels and the susceptibility of these structures to impact damage, a monitoring system will be developed that will record and reveal the nature of impacts to composite cases, allowing confidence in the decision to use/not use a particular structure. A specific example of a government liability due to undetected composite case impact is the Jan 96 catastrophic failure of a Delta II launch carrying a GPS satellite. Delta II as well as many other government and commercial launch vehicles use composite structures, which should be monitored closely to prevent future launch failures. The commercial market also has application in the increasing use of compressed natural gas tanks, both for industrial and automobile applications. Potential government uses extend to any program that uses composite structures or other high value assets that would benefit from continual monitoring. A joint industry/government composite conference at Los Angeles Air Force Base was presented with this concept on 06 May 1998, and upon conclusion of the conference, every working group recommended development of this technology as a mutually beneficial investment. The system could be used for impact detection, lifetime monitoring, environmental characterization/ monitoring, and transportation monitoring of any structure, although the most obvious payoff concerns composite structures due to their susceptibility to impact.

DESCRIPTION: The proposed system includes a small, unobtrusive, wireless sensor node containing temperature, humidity, and acoustic emission sensors. A distributed acceleration and strain sensor network would be placed on the structure within a single optical fiber. A microprocessor in the node would accumulate, analyze and communicate data in a real-time format. The node would be part of a network which

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1M

Estimated Program Duration: 12 to 24 months

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Aircraft Sustainment -- Aircraft sustainment has three basic technology areas: robust and reliable designs, parts obsolescence decision tools and simulation models, and advanced industrial sustainment practices. These requirements include low-cost, low volume manufacturing, rapid repair and remanufacturing, and increased readiness support. Sustainment and readiness technologies will enable the life extension of aging systems, product and process enhancements, and reduce weapon system life cycle costs. Many of the same issues facing the DoD's aging aircraft are encountered by commercial airlines as they extend the life of their fleet. By working together, solutions to this common problem can be developed.

ML-3

TITLE: NONDESTRUCTIVE EVALUATION RECORD RETENTION

OBJECTIVE: The proposed program will address the issues associated with the retention of digital NDE data records for extended periods. The current aging aircraft fleet requires continuous monitoring with advanced nondestructive evaluation (NDE) techniques that are increasingly based on digital systems. While previous film and paper based reports could be

rates. The identification of system-wide problems and the development of cost-effective maintenance strategies based on historical experience. This project will directly support the area of aircraft sustainment.

DESCRIPTION: Evaluate and adapt data storage methodologies used in the medical and astronomy fields to NDE requirements. The data to be archived is currently located at geographically separated sites; the manufacturer, subcontractors to the manufacturer and maintenance depots with little probability that economics would permit the collection of the information at one central location. Therefore, the program will build on the results of a DARPA sponsored Materials Partnership program at Lockheed which developed the protocols to integrate NDE data with design and manufacturing data at extended locations using the Internet. Since it is unlikely that the NDE market would be large enough to support a unique standard, the medical system or astronomical system will be utilized as the kernel and an NDE shell will be added to meet the unique NDE requirements. Data bases and network nodes would be established at a minimum of one ALC and one engine manufacturer to demonstrate the integrated network capability. The commercial aircraft industry has even more rigorous requirements for such data archiving since the FAA requires the storage of NDE data for 99 years. This program will develop and test strategies to implement a long-term digital data storage capability, which avoid the current problem of rapid obsolescence of the media and read-out hardware.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1M

Estimated Program Duration: 36-42 months

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TITLE: ADVANCED DAMPING CONCEPTS FOR LOW PRESSURE TURBINE BLADES

OBJECTIVE: This program would develop and validate two alternate approaches to gas turbine engine blade and rotor damping. Pratt and Whitney (PW) and General Electric (GE) have both identified low-pressure turbine (LPT) damping as critical to the Joint Strike Fighter (JSF). PW JSF design studies show that a shroudless LPT would significantly reduce weight and cost. AFRL/VASV has efforts underway to characterize particle and powder damping mechanisms and their ability to damp a turbine engine blade. The proposed effort will provide a durability assessment for these damping technologies. Commercial engines are not immune to turbine HCF problems. In addition, advanced designs, such as the PW6000, PW8000, and the CFM56 growth engine, will use advanced technologies from the Integrated High Performance Turbine Engine Technologies (IHPTET) program, specifically high speed core technologies. As in military engines, a shroudless LPT would significantly reduce weight and cost.

DESCRIPTION: The application of advanced mechanical damping systems to gas turbine engine blades and rotors will enable robust designs, thereby saving weight and cost. Successful proposals in this area would select and develop two advanced damping concepts (e.g., particles, powder, coatings, friction, ring-sleeve), considering the damping mechanism as an integral part of the blade/rotor design. Full durability testing -- no less than 2000 hours the -- would be conducted, for each selected concept, on a damper/blade/rotor system at temperature and under load (steady and vibratory).

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1.6M

Estimated Program Duration: 36 months

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PR-5

TITLE: HIGH TEMPERATURE ELECTRONICS FOR EMBEDDED CONTROL

OBJECTIVE: Develop high temperature processing and signal conditioning modules that will enable the implementation of distributed control architectures for gas turbine engines. Distributed control systems have demonstrated substantial benefits over centralized systems in terms of development, production, and maintenance cost in numerous commercial applications. Distributed control will reduce organizational level maintenance burden and spares inventories. The distributed built-in test capability of these configuration decreases fault isolation time and increases diagnostic accuracy. Removal and replacement of "good" components should be virtually eliminated. Nonrecurring control system costs, and therefore engine development costs, will be lower. Control system designers will be able to use a simple building block approach with off-the-shelf modules to implement a system that meets engine requirements. The modular nature of a distributed control system makes it more tolerant of parts obsolescence, a significant support cost driver for current control systems. Replacement of obsolete modules and system requalification is straightforward to compared to the level of effort required to replace an obsolete full authority digital electronic control (FADEC) in a conventional centralized engine control system. These technology payoffs are significant for both military or commercial gas turbine engines.

DESCRIPTION: Distributed control systems are not currently used for engine applications because conventional silicon electronics would require active cooling system. Elimination of the requirement for active cooling with high temperature electronics (at least 225°C) and packaging is necessary to make distributed control feasible. Previous efforts have made significant strides in the development of these technologies, but schedule and budget limitations prevented resolution of some key module-level issues. This effort should focus on those issues, namely optimization of the module power and data bus interface cost weight and volume. Minimization of module size is essential. Successful proposals in this

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PR-7

TITLE: PROBABILISTIC REASONING FOR GAS TURBINE ENGINE HEALTH MONITORING

OBJECTIVE: The objective is to development a probabilistic (statistically based reasoning) diagnostic and prognostic system (ProDAPS) capability for gas turbine engine health and life monitoring. The development of any advanced engine health monitoring system is limited by the capability of that system to apply reasoning i.e. to accurately and timely define what, when and why. The development of a true reasoning intelligent based diagnostic and prognostic system will provide the military with a capability to operate propulsion systems on an on-condition based maintenance philosophy; opposed to the current scheduled and unscheduled maintenance approach. This capability will enhance operational capabilities and safety, whilst reducing operating life cycle cost. The direct relationship of operational capability and cost can be translated to the commercial world as an enhanced revenue enabler.

DESCRIPTION: A ProDAPS system will monitor, trend, diagnose, predict and inform. It will assist in the development of a predictive methodology that is able to deduce accurately the outcome of an event, so as to reduce engine life cycle costs and enhance operational capabilities. ProDAPS will provide real-time diagnostic and prognostic assessment of creep and fatigue life, component condition and life consumption, engine performance and engine health. The system will also integrate

Estimated Program Duration: 24 to 36 months

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VA-1
TITLE: ADVANCED COMPUTATIONAL TECHNIQUES FOR CAVITY ACOUSTIC PREDICTION

OBJECTIVE: To develop fast, inexpensive analysis tools to predict cavity acoustics. The incorporation of advanced acoustic suppression devices in cavities requires software that can accurately predict the behavior of these devices. Weapon system designers who want to use active suppression in weapons bays need fast preliminary design tools to tell them the level of suppression they can expect (so they know what loads the aircraft and weapon will see in the bay).

Military benefit includes expansion of the flight envelope where weapons can be released, decreases in the number of disabled stores due to acoustic damage, reduction in aircraft flight weight due to less "beefy" structure required (lower acoustic loads), longer structure life, and lower system life-cycle costs. Similar gains can be described for a related Navy problem. A resonant cavity structural fatigue is present in torpedo launch tubes in Navy ships, and similar types of fixes can be applied to that problem.

Predicting and controlling the cavity acoustic environment is a concern for the entire aircraft industry. As discussed above, military vehicles carry

or 2) an application service would be provided. In the former case, customers license the tool outright and use it routinely, developing their own expertise in application. In the latter case, customers have occasional need for application but do not wish to invest in developing their own expertise.

DESCRIPTION: The flow environment of internal weapons bays (generically referred to as cavities) of military air vehicles are characterized by highly turbulent, unsteady flow with elevated pressure levels due to acoustic resonance. This environment is damaging to both the structure of the vehicle itself (acoustic fatigue) as well as any equipment being carried in the bay. Typically, weapons or avionics packages carried in bays have sophisticated electronics that are susceptible to vibration damage.

In order to develop acoustic suppression technologies, it is necessary to be able to predict the acoustic environment in cavities with reasonable level of accuracy. This has not been realized due to the complexity of the flow fields involved. State-of -the-art computational fluids dynamics (CFD) codes are capable of predicting the gross steady flow characteristics, but have difficulty predicting the time variant components of the flow. This is due to the physical models in these codes which attempt to account for the effect of fine scale turbulence, but do not actually model the unsteady behavior directly. Such models have proven inadequate to predict the effect of the large-scale turbulence in cavity flows. Nor do they yield the desired unsteady characteristics.

New techniques are being developed at the basic research level for prediction of highly turbulence and unsteady flow fields. These techniques include large eddy simulation (LES), direct numerical simulation (DNS), and neural network concepts. These techniques have shown promise for predicting highly turbulent unsteady flows in small-scale laboratory situations as well as full scale acoustic environments for aircraft engine exhaust. A natural extension to cavity flows is proposed.

It is expected that modeling efforts will rely on very high quality, cavity flowfield information, in addition to detailed descriptions of the effects of devices used to modify these flowfields. It is appropriate to propose to run

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VA-5

TITLE: LIFE CYCLE COST SAVINGS AS A DISCRIMINATOR FOR AFRL TECHNOLOGIES

OBJECTIVE: Technical planners across the DOD are required to prioritize the development of technologies for new systems relative to user needs. Designs for these new systems or technologies typically only exist at the conceptual or preliminary design level, yet trade studies must be performed to assess cost and effectiveness, as well as overall affordability. The MAJCOM/Users want to incorporate life cycle affordability into the decisions they make on what concepts/solutions/technologies are to be funded. That desire requires the technologist to be able to show the estimated cost and cost savings just as fast and effectively, as they have been able to show the impact to performance in the past. The challenge arises from technologists being trained from college through on-going job activities in the performance area of their technologies. They have not received the affordability, cost estimating, or cost savings training during that time. However, this challenge can be mitigated if the current investments in cost tools are integrated into a desktop analytical environment that can be easily used with little or no formal training. Collaborative Enterprises/Engineering is being implemented within Air Force Materiel Command to improve the quantity and quality of information available to the designer/planner to make the necessary performance design and cost trades. Designers require a methodology and tool-set which provide concept cost and affordability estimation based on industry standards for development and production costs, and accurate

affordability and assure the system is useable by the average military engineer, analyst, program manager or decision maker.

The actual needs that this system would fulfill are too numerous to mention one by one. It is clear that directorates of AFRL are starting to focus in this area. However, predominately it has been on a directorate by directorate basis, and this DUAP could help to integrate the advancements made from each of these areas for the benefit across AFRL. Known areas that are pursuing some specific investments in this area include:

- **AFRL/IF is attempting to integrate cost and affordability into the CEE structure**
- **AFRL/ML continues to pursue analysis of cost of the technologies via SBIR's**
- **AFRL/VA is pursuing activities to respond to the FWVP initiatives of which approximately 50% are cost/affordability goals as well as answering some DARPA UCAV questions on the affordability**
- **AFRL/SN is investigating automation of cost trade-offs for the MALD program**

The resulting product has applications for both DOD and commercial customers in assessing new technology's investment cost and life cycle affordability as part of a system and sub-system development, life extension or modernization efforts. Additionally, developers of space, naval, and ground systems could use this methodology to assess their program's investment costs and affordability as well as conduct trade studies on these factors. As the use of Collaborative Enterprise/Engineering expands to other non-military industries as it has already done with Boeing on the 777 and Chrylser on the Dodge Neon, the need for an affordability tool compatible with the environment also expands. Any of the advancements to the integrated modeling environment could easily be used by any commercial industry that fundamentally uses many of the same technologies.

DESCRIPTION: The Integrated Desktop Analysis and Planning System (IDAPS) for Technology Evaluation tool is to provide the analyst, planner and decision maker a single means to easily evaluate a large number of

technology requirements. This effort will build a system that provides the following capabilities:

- Trades cost and design parameters to achieve affordable and acceptable performance.
- Provide cost estimates of advanced concepts.
- Identify cost "drivers" for EMD, production, or operations early in the technology design process.
- Provide full Life Cycle Cost evaluation of system concepts.
- Provide data to support technology investment strategy and/or test demonstration decisions.
- Support investment and technical planning.

The tasks associated with this modeling and simulation integration effort will be defined in detail. The milestones will be to assure the development activities include working prototypes for review within various AFRL organizations no less than every 4 months to assure that the system is actually accepted by the users and assist in assuring AFRL technologies are receiving priority from the using commands.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $3M

Estimated Program Duration: 24 months

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As the Dept. of Defense (DoD) seeks to do its part in balancing the national budget, affordability is becoming the new watchword in aircraft programs, just as it is in other areas of defense spending. The development of advanced technologies for air vehicles is also under increasing scrutiny. As a result, the press for improved performance from promising new technologies must now meet the additional test of cost versus performance. Technology selections can have significant impacts on the life-cycle cost (LCC) of an air vehicle, including development, production, and operating & support costs. Unfortunately, traditional estimating tools are not capable of timely assessment of these impacts for a number of reasons:

1) Historical databases may not apply.
2) New aircraft databases (F-22, F-18 E/F) are useful but incomplete because these aircraft have not been produced yet.
3) Advanced technology costing requires detailed adjustments to component level WBS data, but traditional cost models estimate at the subsystem WBS level.
4) Gathering the inputs for traditional cost models, even at the subsystem WBS level, can be time consuming.
5) Traditional cost models require economic and programmatic inputs that make them difficult to use by engineers (non-cost experts).

An estimating tool is needed that will solve these problems.

The same affordability concerns that drive government aircraft technology investment strategies also drive industry technology decisions. This is true in both the commercial and military markets. In the commercial world, low operating cost has always been a key selling point. Airlines are profit-making operations, and each aircraft's acquisition and operating costs relate directly to the bottom line. Manufacturers choose advanced technologies to include in new aircraft based on affordability factors: reduced crew size, low fuel consumption, reduced maintenance actions, etc. In military markets, the emphasis on affordability becomes steadily stronger as defense budgets steadily decline. Manufacturers who invest IRAD funds in cost-reducing technologies establish an advantage for future competitions. Therefore, a tool that allows manufacturers to accurately assess the cost impacts of a new technology early in the evolution of that technology would be of great value in both military and

c) New graphical user interface (GUI) techniques gather and record "soft" engineering data
d) Artificial intelligence tools help flesh-out design impacts from "soft" engineering data
e) Integrated resizing algorithms determine overall cost impacts of advanced technologies on historical/new aircraft

3) Automates selection of appropriate method (cost model/database) for VA engineer
4) Standardizes process for cost comparison of new technology alternatives

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $200K

Estimated Program Duration: 24 months

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VA-4

TITLE: DISCONTINUOUS FIBER REINFORCED THERMOSET COMPOSITE STRUCTURES

OBJECTIVE: Develop air vehicle structural concepts based on oriented discontinuous fiber thermoset composite prepreg material systems. This technology addresses the Air Force's goal to reduce the cost and weight of weapons systems. Structures fabricated from discontinuous fiber

weight reduction of the structures for highly energy efficient automobiles, trucks, buses, trains, commercial aircraft, and space systems. Low cost, composite product forms are necessary to make extensive use economically viable. Discontinuous fiber composite materials will allow very low cost net shape forming of a wide variety of parts similar to forming of sheet metal. The automotive industry has shown significant interest in discontinuous fiber composites and will be targeted for initial applications. In addition, a wide variety of upscale sporting good products from skate boards and wind surfers to bicycles, golf clubs and more, will benefit from the low cost production and high performance offered by this technology.

DESCRIPTION: This program is focused on stiffened, moderate to lightly loaded, buckling critical air vehicle structures fabricated from discontinuous fiber thermoset composite prepreg material systems. This category of structure does not require the mechanical performance of continuous fiber reinforced composite prepreg materials. The discontinuous material form of interest is based on conventional, continuous fiber reinforcements that have been selectively cut or broken into shorter lengths. These types of discontinuous fiber reinforced materials retain a high degree of stiffness and are highly amenable to low cost component fabrication techniques due to the inherent comformability of the material. Conformability will allow one-piece integrally stiffened structures. This program shall identify several air vehicle structural design applications exploiting the unique characteristics of these materials. One or more concepts shall be demonstrated through fabrication and structural test. The mechanical properties of the material shall be established before and after fabrication. The weight and cost savings provided by the demonstration components shall be documented.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $400K
Estimated Program Duration: 24 to 36 months

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Distributed Mission Training -- Simulated training requirements are not unique to the DoD. Development of Distributed Mission Training (DMT) will result in a network of training assets, including live, simulated and computer-generation, which allows multiple players at multiple sites to engage in complex, scalable and tailorable synthetic training environments that mirror the real world, be it a battlefield or an industrial facility. This initiative will seek to partner with commercial firms to develop simulated training capabilities that will not only meet DoD continuing need for simulated training but will also be applicable to the growing need in commercial industry.

HE-2

TITLE: SUPER HIGH-RESOLUTION PROJECTOR FOR HIGH-DEFINITION MILITARY AND COMMERCIAL VISUAL DISPLAYS

OBJECTIVE: Develop a new class of projector technology with four times the pixel resolution of current high-resolution systems. This resolution will deliver realistic target definition in out-the-window military simulators and provide an advanced projection technology for commercial applications including entertainment, visualization, and CAD/CAM. During this two-year program, a 5120 x 4096, 60 Hz, non-interlaced projector prototype will be designed and developed. The prototype will be evaluated for image acceptability and then the technology (including revisions suggested during the image evaluation) will be part of an industry proposed program with a commercially viable manufacturer on the original team that proposes.

DESCRIPTION: The usefulness of flight simulators for military training has been limited by the types of visual systems that provide out-the-window imagery. For a representative full-field-of-view display, conventional devices are limited to the nominal equivalent of 20/80 visual acuity, meaning that the visual acuity for a scene in the display is at best that of a person who requires significant correction for myopia. In operational terms, fighter pilots, who are being trained in air-to-air and air-to-ground weapon delivery, need to distinguish the aspect angle of a target at a slant range of approximately 12000-ft. Yet current flight simulator displays only provide enough detail to judge aspect angle out to a slant

develop a super high-resolution projector that will display high-resolution imagery from their top-of-the-line image generator (IG) products. In addition to the military requirements for high-resolution imagery, they see a market for high-resolution entertainment, virtual reality, commercial simulation (auto, boat, manufacturing), visualization of products and processes, and CAD/CAM to name a few.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1.9M

Estimated Program Duration: 24 Months

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VS-2

TITLE: DEVELOPMENT OF SPACE HAZARDS ANALYSIS WORKSTATION (SHAW) SOFTWARE MODULE

OBJECTIVE: Current satellite planning activities involve detailed safety analyses to control the risk of space hazards, including collision and close approach, debris and chemical cloud impact, controlled reentry of spacecraft, directed energy, radio frequency interference (RFI), and space environment effects. This Dual-Use Technology Focus Area's goal is to develop the Space Hazards Analysis Workstation (SHAW) space safety analysis tools and expertise to plan and conduct safe missions by assessing mission hazards, and to commercialize this capability to the growing

assessments of the effects of new systems on the space environment as well as the effects of the environment on those systems.

In addition to the military relevance, SHAW has a very strong commercial viability. The booming commercial satellite market has a very strong need to assess the risk posed to their systems from the space environment. Presently, there are no commercially available software tools to assess the risk from the space environment. Although DoD space systems must survive a harsher environment (withstand hostile attacks), both military and commercial systems face the same day-to-day space hazards.

DESCRIPTION: The AFRL Space Debris Research Program has sponsored the development of the Debris Analysis Workstation. This package is an ensemble of spacecraft breakup, trajectory propagation, and data visualization software tools that are cohesively integrated into a single user-friendly analysis environment with a graphical mouse driven user-interface. Additionally, other AFRL projects have developed tools for laser clearance, RFI analysis and space environmental effects. The goal of this project is to provide a single self-consistent environment for constructing and performing space mission studies using various codes in a coordinated and simplified way. The codes to be integrated would be selected from existing ones developed by AFRL, the Aerospace Corporation, other Government agencies, and commercial industry. We have already discussed the commercial viability of this project with representatives from private industry, and the initial feedback is that there is a potentially strong market for this type of capability in the private sector.

Program Plan

The proposal for a Dual-Use Technology Focus Area begins with AFRL development, then demonstration and transfer of SHAW software to a commercial partner. This partner will provide feedback and technical requirements to AFRL to develop/modify SHAW to meet the commercialization market forecast for this Dual-Use Technology. Both organizations will exchange technical expertise in the area of space hazard modeling and analysis and cooperate on initiatives of mutual interest including technology application and process improvement. AFRL will provide engineering and technical services for the commercial partner,

AFRL portion of this project will be accomplished in FY99-00, while the commercial portion will be completed in FY01. The extra year is for the commercialization portions of the project.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $2.6M

Estimated Program Duration: 30 months

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Fuel Efficiency and Advanced Propulsion Technology -- DoD will benefit significantly from the development of fuel-efficient, low-emission power sources. This need is pervasive among all of the services due to the cost and logistics burden of providing fuel to combat forces. This initiative will focus on the efficient increase of speed and thrust, reducing fuel requirements, and reducing emissions. The driving forces for improved power and propulsion in the consumer sector are the same as for the military: increased density, enhanced safety, lower cost and environmental friendliness while still increasing power/energy density. The results of these initiatives will be directly applicable to both the military and commercial markets.

ML-1

TITLE: SPRAY FORM PROCESSING OF NI BASED SUPERALLOYS

OBJECTIVE: The proposed program will address processing science issues associated with the spray-forming and billet conversion of nickel-base superalloys. Spray forming has the potential to reduce the cost of manufacture of many of the most critical components used in aircraft engines-cases, rings and disks. These components represent a $270 million annual worldwide market. Incorporation of spray forming, a direct one-step conversion from molten metal to a semi-finished metallic article in minutes, will result in projected annual cost savings of $40 million for US-based manufacturers. A recent industry analysis determined that over

advanced propulsion systems and to provide improved technology for life extension and sustainment of military aircraft.

DESCRIPTION: Evaluate and develop models of the spray forming process in order to control preform shape, porosity and starting microstructure. Develop models for the constitutive behavior and microstructure evolution during billet conversion for spray formed materials and compare resultant mechanical properties with compacted and extruded powder metallurgy materials. This processing technique has the potential to significantly impact military engines such as the F100-220/229 and F119 as well as commercial engine examples. Initial demonstration of the process on candidate parts will be completed in the final phase of this effort. Spray formed components have been identified for use in commercial propulsion systems such as Pratt and Whitney's PW4000 series engines as well as the General Electric GE90 series engines. In addition, Rolls Royce has expressed interest in utilizing spray formed materials in their engines. In addition, components from this process will also be used on commercial airframes such as the Boeing 777, 747, MD-11, DC-10 and A340.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1.2M

Estimated Program Duration: 36 months

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for materials from R&D to manufacturing production is still about 15 years. The vision for this initiative is to achieve affordable metallic materials and processes with accelerated implementation for aerospace. Benefits to the Air Force will be reduction in acquisition cost of 50% of metallic components for the JSF. An additional benefit will be the reduction of system life cycle costs to levels below that of current generation advanced components and structures. Engine efficiency and durability is of paramount importance to the commercial airlines. These parameters are driven by the same materials and manufacturing processes which drive the performance goals in military hardware. Frames, cases, disks, shafts, airfoils, and fuselage are common in both military and commercial engines and airframes. The infrastructure, which manufactures airframe and engine hardware in the commercial sector, is the same as that in the military. The technologies, materials, manufacturing process, and tools to be developed in this initiative are of mutual interest to both defense and commercial needs. The economies of scales inherent in the commercial marketplace makes this initiative viable even without significant military buys.

DESCRIPTION: This effort shall address the affordability of man-rated weapon systems through a cooperative initiative involving government, industry OEMs, and their suppliers to address materials, processes, manufacturing infrastructure, and the use of process and manufacturing simulation tools. This activity will employ a “top down” approach to developing the strategy, goals, planning, management, integration, and execution. The effort will be structured as a time phased activity toward major milestones and exit criteria. The effort will identify major drivers to cost and execute activities aimed at specific affordability goals. This project will directly support advanced propulsion technology and the sustainment of Air Force aircraft.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $8080K

Estimated Program Duration: 60 to 72 months

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PR-2

TITLE: ADVANCED HIGH WORK TURBINE

OBJECTIVE: To develop the technology to design the next generation of high work, high efficiency, single stage high-pressure turbines. All future military turbine engines will benefit from an improved high work turbine. High horsepower output at high efficiency will reduce engine size and improve fuel consumption. Reduction in engine size reduces weapon system size, cost, weight and can increase survivability and operability. Commercial aircraft will benefit from smaller more fuel-efficient engines. Low cost of ownership and excellent operability are prime factors in commercial gas turbine engine operations. Improvements in turbine power (work output) offer greater benefits to both commercial aircraft engines and industrial and marine applications.

DESCRIPTION: Advanced high work turbines are needed to support the next generation of high-pressure ratio, low fuel consumption turbofan engines. This technology is characterized by high turbine expansion ratios, corrected work, and Mach numbers. These turbines will need to provide high horsepower output at high efficiency. The aerodynamic and film cooling technology for achieving these characteristics requires further development and maturation. A combination of cascade, short duration and steady-state aero and heat transfer testing will be required to develop the flow path geometry to meet the performance objectives of these turbines. Turbine pressure ratios over four and thermodynamic efficiency over 85% are top objectives of this program. The AF DUS&T program will develop the design data and performance concept feasibility for the industry to design and produce these next generation turbines.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $800K

Estimated Program Duration: 36 to 44 Months

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PR-3

TITLE: ADVANCED THERMAL PROTECTION COATING

OBJECTIVE: To develop the technology for the next generation of low conductivity, long life thermal barrier coatings for turbine engines. All military turbine engines will benefit from an improved TPC. Hot section durability is one of the leading maintainability cost drivers for turbofan/jet engines in the Air Force. Removal for cause, (before scheduled maintenance) of engines due to turbine blade and vane thermal erosion and cracking is a significant life cycle cost driver. For every 30 to 60^{o} F reduction in metal temperature, the field life of that part can increase by a factor of two. There is a potential for annual cost savings of hundreds of millions of dollars. All turbine engines will benefit from an improved TPC. Hot section durability is one of the leading maintainability cost drivers for all turbofan/jet engines. Commercial airlines maintenance cost are very dependent on "time on wing", therefore technologies that improve that statistic are of very high interest. There is a potential for annual cost savings of hundreds of millions of dollars.

Description: Advanced thermal protection coatings (TPC) are comprised of a thin metallic bond coat and a thicker ceramic topcoat that increase thermal resistance of the metal surface to which they are applied. The application of improved bond coats and ceramic topcoats are being developed through a combination of Air Force 6.2 and industry IR&D programs and funding. The objective of existing programs is to develop and demonstrate the feasibility of a TPC that has an increased thermal resistance and durability over existing TPC's used in current military and commercial engine production programs. After completion of the baseline programs, the feasibility of the TPC systems will be demonstrated and effort on scale up and development of production processes can be started. This will include life and durability testing to determine erosion and spallation characteristics. The application process and quality control

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PR-6

TITLE: LOW COST/HIGH PERFORMANCE HYDROCARBON ROCKET FUELS

OBJECTIVE: Develop alternatives to RP-1 (the standard hydrocarbon rocket fuel) that reduce cost or increase performance. An improved hydrocarbon fuel would have high payoff for several Air Force and DoD launch systems. A Space Operations Vehicle would benefit in terms of reduced operational cost and simplified logistics for aircraft-like operations if JP-8, available on all Air Force bases, could be used rather than RP-1. In addition to being much higher cost, a specialty fuel such as RP-1 would require a dedicated acquisition and storage system at all operational sites. RP-1 is now used in most current and planned military space launch vehicles, including Delta, Atlas, and Lockheed Martin's Evolved Expendable Launch Vehicle (EELV) now in development. A higher density, higher performance, or lower cost hydrocarbon fuel could be substituted into any of these systems once it is shown to be acceptable for rocket engine operation. NASA is interested in assessing JP-8 for the Liquid Flyback Booster (LFBB), a liquid version of the Space Shuttle Solid Rocket Motors. The LFBB is reusable, flying back to the launch site after use via turbine engines. The logistical advantages of using the same fuel for both the booster and gas turbines are significant, in addition to the obvious cost advantage of using a lower cost fuel. As the Air Force "migrates to space", it is to be expected that liquid hydrocarbon rocket

advantageous in this marketplace. RP-1 and alternative hydrocarbons are good examples of dual use fuels, finding wide use in both commercial and military systems. The LFBB (as discussed above) is an example of this. Potential commercial participants include Lockheed/Martin, Boeing, TRW, and NASA.

DESCRIPTION: Recent developments in synthetic hydrocarbon fuels have demonstrated high energy and density, potentially allowing payload increases of 10 percent or more over current systems and significant savings for military launches or profits for commercial launches. The recent availability of Russian rocket engine and fuel technology has also led to interest in reassessing the formulation and specification of RP-1 (MIL-P-25576C), the standard US kerosene (hydrocarbon) fuel for government and commercial space launch. Russian kerosene (RG-1) is more dense than RP-1, with a high volumetric loading payoff. The US propulsion industry is also assessing lower cost alternatives to RP-1, such as JP-8 ($0.90/gal vs $2.30/gal for RP-1), and high energy-density fuels such as RP-2 (quadricyclane) or JP-8X. Other synthetic hydrocarbons are also being developed in government and industry labs. Data is required to assess performance of these fuels under realistic rocket engine conditions.

The planned program will determine the viability of improvements to RP-1 as well as assess lower cost or higher performance alternatives. Studies with refineries will determine the feasibility and cost of increasing RP-1 density to that of RG-1. The cost as a function of production quantity and specification properties (density, sulfur level, etc.) will be determined. Lower cost fuels such as JP-8, JP-8+100, and JP-8X will be compared to an RP-1 baseline to determine if they have sufficient thermal stability and combustion performance. Higher energy density fuels such as RP-2 and other strained ring compounds will be analytically and experimentally evaluated to determine their cooling capability and engine combustion performance.. The tests will include fuel-material compatibility, especially with copper cooling channels, and will assess sensitivity of fuel decomposition and deposition (coking) in the coolant channels to heat flux, bulk temperature, residence time, and fuel type. The AFRL/PRSF facilities at W-P AFB and the NASA LeRC heated tube facility will be used for these tests. The combustion performance and stability will be determined through subscale combustor tests with existing hardware in the

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PR-8

TITLE: THERMAL SYSTEMS ANALYSIS TOOL

OBJECTIVE: Develop a tool to simulate thermal management/control (M/C) concepts for advanced propulsion technology (space and high speed), power systems, and weapon systems (airframe and directed energy) that truly integrates with the entire system. This is to enable assessment of the thermal M/C design's impact on factors such as the system's overall performance, operability, weight, volume, range, and/or cost. In addition, factors such as fuels, ancillary coolants, trajectory, component/subsystem efficiency, and external (aeroheating, solar insolation) and internal (combustion, power, environmental, avionics) heat loads during on- and off-design conditions will need to be factored into the simulation to identify potential penalties and options to overcome them. This product will provide AF and DOD engineers with the capability to quickly and independently assess thermal system concepts of existing, near- and far-term weapon, power, and air/spacecraft systems on a truly integrated basis. Not only will this approach save significant time when performing trade studies, but it will provide engineers with the ability to

where ever there are thermal related systems and issues, such as, but certainly not limited to space system platforms, commercial aircraft, power plants, hybrid ground vehicles, and locomotive power systems. Further, the applicability of this tool is easily expandable from aircraft fuel systems to alternative thermal fluid systems such as refrigeration, hydraulics, heat exchangers or other mechanical systems. Another commercial venture area is for use as an educational tool to introduce senior and graduate mechanical and aerospace engineering students to the concept of thermal management with its interactions of heat transfer, thermodynamics, fluid dynamics and structures. In addition, it will introduce the concept of system integration during design.

DESCRIPTION: Evaluation of thermal M/C systems are currently accomplished as a serial process and not actively integrated with vehicle trajectory, aeroheating, engine, power generation and/or subsystem performance, efficiency and weight effects that can impact the overall system design. As a result, the thermal M/C system's level of "goodness" or "badness" on an entire system can not be dynamically investigated until late in the design process when it is typically too costly to make modifications to the design. Successful proposals will result in a simulation modeling tool that enables timely evaluation of thermal system concepts on an integrated basis. This includes factoring in the entire system's configuration, propulsion and/or power generation system, trajectory and/or environmental conditions, leading to concepts that meet performance, efficiency and weight goals at times during the design and/or refurbishment cycle when changes are still cost effective. By identifying potential thermal problems and developing solutions to overcome them early in the game will serve as a means for reducing the systems life cycle costs. Further, successful proposals in this topic area should provide a tool with an open object oriented architecture that initially provides the functionality of an engineering code such as the Vehicle Integrated Thermal Management Analysis Code or VITMAC and expand the capabilities to accomplish the objectives above. Integration of other existing and applicable non-proprietary analysis tools developed by the Air Force, NASA and other appropriate organizations should be used to the maximum extent possible in order to reduce developmental time and "reinventing the wheel." Having an open architecture will also provide the means for analysts to incorporate and use their own internally

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Information Systems and Technology -- The advent of the information revolution has significantly increased the need to exchange, manage, manipulate, and protect large amounts of essential information. Technologies developed will provide the tools necessary to facilitate large volumes of information and to alleviate the cognitive "information overload" intrinsic to both the battlefield and the corporate boardroom.

DE-3
TITLE: ULTRA-HIGH DATA RATE OPTICAL COMMUNICATIONS

OBJECTIVE: New field-deployable and space-based laser technology is sought for high data rate optical communications at the 1.55 micron wavelength. Such communications capability will enhance battlefield awareness and enhance global virtual presence by allowing large volumes of data to be transmitted. These sources can also be used for illuminators and designators. This particular wavelength is chosen to leverage off the large investment made by the commercial telecommunications market.

DESCRIPTION: The desired goal for the product is a multi-Watt diode laser with diffraction limited beam quality at 1.55 micron wavelength, that can be modulated at multi-GHz. Particular emphasis should be placed on reliability and compact, robust packaging.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $3.0M

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DE-7

TITLE: ULTRA-HIGH BRIGHTNESS, HIGH EFFICIENCY SEMICONDUCTOR LASER ARRAYS FOR HIGH SPEED READ/WRITE APPLICATIONS AND LASER PUMP SOURCES

OBJECTIVE: New high-brightness, high-efficiency diode arrays are sought for laser pump sources. Such pump sources are desired to make fiber laser and solid state laser systems more efficient. Higher efficiency pumps would lead to lighter weight and smaller packages. Potential commercial applications include high-speed read/write sources, graphic printing sources, and sources for industrial cutting and welding.

DESCRIPTION: The desired goal for the product is a 100 Watt power level at a wavelength appropriate for pumping fiber lasers (e.g. 915 nm, 980 nm, etc), electrical efficiency of greater than 60 percent and sufficient beam quality to allow for 80 percent coupling efficiency into a dual clad fiber. Particular emphasis should be placed on reliability and compact, robust packaging.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $2.4M

Estimated Program Duration: 36 months

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Send proposals for this Topic Area to:

IF-1

TITLE: ANTI-TAMPER TECHNOLOGY EFFORTS

Innovative C4I Technologies: *Secure Handling of Intelligence Data*

OBJECTIVE: The objective is to develop new algorithms and/or apply existing algorithms that perform the robust, efficient, fast, and secure ciphering and hiding of secret messages inside digital images, video, audio, and documents. The effort will further investigate and develop steganographic techniques that provide higher security than naïve least-significant-bit encoding to support covert communications, data embedding, and digital watermarking.

The research conducted in this effort has a military benefit in that it can be applied to covert and extremely secure communications, source authentication and sensor platform signature (i.e. embedding a sensor's ID or platform ID within the imagery). In addition, it has a commercial benefit in that it can be applied to copyright protection for digital imagery, "fingerprinting" of images, and the development of intelligent browsers for imagery or audio databases.

DESCRIPTION:

A. Development and software/hardware-prototype implementation of an image ciphering and hiding scheme for enciphering and hiding of images within carrier images and video clips. The offeror shall demonstrate a prototype implementation of a secure image-ciphering scheme for enciphering/hiding of images and/or documents within carrier digital images generated by a CCD-type camera. Demonstration shall include transmission, retrieval and deciphering of enciphered/hidden images over the Internet.

B. Development and software/hardware-prototype implementation of a source authentication signature scheme for digital images, video, audio, or documents. This shall allow one to embed signatures into digital images, video, documents and audio, and subsequently retrieve embedded signatures from these information sources, providing authentication that the media sources have not been tampered with. The software/hardware prototype shall embed a signature/watermark

developed scheme shall demonstrate retrieval and correlation of the signature/watermark embedded in each source image.

D. Development and software-prototype implementation of an intelligent web-based browser capable of determining which watermarked digital images a user has appropriate access to. The software-prototype will demonstrate real-time checking of the embedded signature/watermark images. Images not authorized by the web browser will not be displayed, while those images containing the embedded signature/watermark will be displayed. This concept shall also be demonstrated for checking audio available for downloading from web-sites.

E. Development and software/hardware-prototype implementation for a Copyright protection scheme for digital images. This shall provide the tools to determine the rightful owner of a digital image. The developed scheme shall allow for customizing the copyright data embedded in the digital image, e.g. date, time, location of creation, user logo, trademark, etc.

The above tasks would provide a suite of tools to support anti-tamper system objectives for secure transmission and protection of digital imagery, video, audio, and documents. Implemented prototypes will also include an analysis of the security of the developed schemes.

SPECIAL INSTRUCTIONS: The successful offeror(s) may receive and/or generate technical data subject to export control in the performance of the agreement. Therefore, prospective offerors must provide a completed and approved DD Form 2345 which certifies the offeror is on the Certified Contractors Access List (CCAL) or the offeror is seeking application to CCAL. Successful offerors must have a completed and approved DD Form 2345 prior to award. For further information on CCAL, contact the Defense Logistic Service Center at 1-800-352-3572.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $1200K

Estimated Program Duration: 24 months

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ML-2

TITLE: WEB-BASED, COLLABORATIVE DESIGN ACROSS CUSTOMER-SUPPLIER NETWORKS

OBJECTIVE: The objective of this effort is a design environment that captures interactions between disciplines and therein, quantifiable interdisciplinary relationships that enable system level trades such as cost versus performance. Fundamental to these interactions is a "distributed modeling" capability wherein multiple designers can interact, enabling each to sketch design additions/alternatives while the design team shares in the visualization and, if required, analysis of the physical model. In addition, all members of the design team can also see the itemized materials and processing costs associated with each component. This effort will directly improve the industrial information overload in the distributed design environment by bringing to bear advanced information systems and the integration of design tool technology.

DESCRIPTION: The web-based design environment (WDE) must enable various engineering, manufacturing, and management disciplines to interact in near real-time over the network. These disciplines must share a single unified model (i.e., a model that involves geometric shapes, physical analyses, manufacturing and in-use process information, etc.). This unified model should be a hierarchy of objects that are needed to represent the various engineering processes. This model should be distributed across a network, with portions resident on different machines that are running various operating systems. To achieve maximum

Motif for Unix platforms, Microsoft Foundation Classes on Windows NT/95, and Java on all supported platforms. Proposals shall address coordination with on-going, related Air Force, Navy and Army programs.

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $900K

Estimated Program Duration: 32 to 36 Months

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VS-1

TITLE: ADVANCED RADIO FREQUENCY (RF) COMPONENT TECHNOLOGY

OBJECTIVE: The thrust area for this research is Information Systems and Technologies. The military objective is to have high-efficiency, lightweight, commercially produced, space-qualified RF components in order to reduce launch costs and increase system capabilities in military communication and radar satellites. These same improvements can also apply to commercial systems such as communication and earth mapping (synthetic aperture radar) satellites.

DESCRIPTION: As communications rely ever more on RF signals in an RF cluttered environment, there is a great need to develop radiation hardened, efficient, light-weight, and low cost RF technologies. The trend

RF circulators. In low-loss phase shifters, the objective is to develop, demonstrate, and manufacture low cost (less than $30 per unit) phase shifters with a loss of about 0.1 dB/bit. The current technology is an efficiency of approximately 1 dB/bit for a price of $30 each. Increased efficiency reduces power consumption, waste heat, satellite weight, and launch costs. For RF circulators, the objective is to develop, demonstrate and manufacture low-cost circulators for use in RF networks. Presently, there is a need for affordable circulators with adequate isolation (more than 30 dB) and low insertion loss (less than 0.1 dB) for use in phased-array antennas. Current capabilities are approximately 23 dB of isolation, an insertion loss of 0.2 dB, and a cost of approximately $300 each. Military (i.e., X-band) and commercial space applications share the need for components with reduced cost, weight, noise, and size (on the order of a millimeter thick).

ESTIMATED FEDERAL FUNDING CONTRIBUTION: $800K

Estimated Program Duration: 18 to 24 months

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